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# INTELLIGENT EDITING ASSISTANT

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## INTELLIGENT EDITING ASSISTANT

A word processing application enables input, editing, formatting and output of text. The word processing application also provides advanced features such as spelling and grammar correction for proofreading. Some word processing applications even employ a machine learning model to provide better proofreading capability. However, a conventional word processing application lacks understanding of a user's writing style and thus, cannot provide editing suggestions aligned with the user's writing style.

For example, when a user writes a novel using an online document processing application, the user may set a tone of the novel to be the third person past tense. Thus, the user would try to use the third person past tense in prose or narrative of the novel and not in dialogues. However, if the user makes a mistake and writes a sentence in narrative using the first person present tense instead, the conventional word processing application would not catch the mistake as long as the sentence is grammatically correct. Also, the user, as an author, may be known to use a distinctive writing style (e.g., punching short sentences) for an action scene. In case the user strays away from the distinctive writing style, the conventional word processing application would not make a suggestion to sentences in the action scene to conform to the distinctive writing style. Accordingly, a technique is proposed for intelligently assisting a user to edit or write in accordance with a given writing style using an editing assistant service of a cloud storage system.

A cloud storage system used herein refers to a system including a cloud-based environment (including a server and a data store) connected to a user device via a network. The server may host a platform (hereinafter, the platform). The platform can provide one or more applications such as an online document processing application, a file storage application, etc.

The platform may enable a user to access and edit documents via a graphical user interface (GUI). Thus, users can write a novel using the online document processing application and store the novel as a file using a GUI of the file storage application of the platform. A user used herein refers to a person having a user account associated with the platform and communicating with the platform using a user device over a network. Some examples of the user device include desktop computers, laptop computers, tablet computers, mobile phones (e.g., smartphones), or any suitable computing device. Thus, any communication to and from a user described herein necessarily involves communication to the user device of the respective user. GUIs referred to herein may be provided by a web browser or a mobile or desktop application.

A new feature provided by the editing assistant service may be added to the platform as plug-in software and may be visible on the GUI when the online document processing application is executed. The new feature can be provided using a GUI component representing an intelligent editor mode that makes editing suggestions for the user as he or she enters content using the online document processing application. The intelligent editor mode can be used as the user enters content, thereby incorporating any changes and revisions when providing editing suggestions. Additionally, the intelligent editor mode can be implemented as a type of a check similar to a spelling or grammar correction, and thus can process the entire text of the online document at once upon a request. A machine learning model associated with the editing assistant service can be used in addition to any existing machine learning model associated with the spelling and grammar corrections by the online document processing application. The data store may store data (e.g., editing suggestions, documents) resulting from communication between user devices and the platform using GUIs associated with the editing assistant service.

Alternatively, the editing assistant service may be provided by any system outside the cloud storage system.

The editing assistant service utilizes a machine learning model to assist a user in creating or editing an online document in accordance with a particular writing style. In the intelligent editor mode, the editing assistant service determines a writing style designated for a section of or the entire online document and identifies a completed sentence(s) or paragraph(s) in the online document to be processed for editing suggestions. The editing assistant service then utilizes a machine learning model to determine whether the identified section of the text is consistent with the writing style of the user, as well as to predict a word, phrase, sentence, and/or paragraph for editing. The prediction would reflect content or subject matter of the identified section of the text in accordance with the writing style. The editing assistant service presents the predicted word, phrase, sentence, and/or paragraph as an editing suggestion to replace the identified section of the online document.

Figure 1 illustrates a flow diagram of a method for intelligently assisting, creating, or editing an online document that is stored, or will be stored, by the platform. First, at block 110, the editing assistant service can determine writing style designated for an online document supported by the online document processing application of the platform. Writing style used herein generally refers to a choice of words, sentence structure, and/or paragraph structure for expressing ideas effectively. The writing style can be categorized based on tense (i.e., a verb tense), scene, genre, and/or author preference(s). The editing assistant service can present a variety of writing styles to the user and receive from the user device a selection of writing style or any combination of the writing styles to be used in the intelligent editor mode.

Next, at block 120, the editing assistant service can determine a subset of content (e.g., text) in the online document. For example, the editing assistant service can identify immediately completed sentences or paragraphs in the text of the online document as the subset. As another example, the editing assistant service can determine any particular section of the text identified by the user as the subset of the text in the online document.

Then, at block 130, the editing assistant service can determine whether the subset of the content in the online document is consistent with the writing style using a machine learning model. The editing assistant service can train the machine learning model using blocks of content from published books and/or the user's previous works. The machine learning model may correspond to a model artifact that is created by the editing assistant service using training data that includes training inputs and corresponding target outputs (i.e., correct answers for respective training inputs). The editing assistant service may generate training data that includes one or more training inputs and one or more target outputs. The training input may include blocks of content from published books and/or the user's previous works. Each block would be labelled (or annotated) with a writing style such as a type(s) of a tense, a scene, a genre, and/or an author name as an input to the machine learning model. The target output may include characteristics of sentence structure (e.g., specific words (e.g., a particular tense for verbs, a repeatedly used adjective) or phrases in the text, a sentence length, a type of sentence (e.g., simple sentence, compound sentence, complex sentence), an active or passive voice, etc.) of the blocks of content.

During the training of the machine learning model, patterns in sentence structure for various writing styles in the training data that map the training input to the target output can be found. The trained machine learning model can then capture these patterns by specific writing styles. The machine learning model may be composed of, e.g., a single level of linear or non-

linear operations (e.g., a support vector machine [SVM] or may be a deep network, i.e., a machine learning model that is composed of multiple levels of non-linear operations. An example of a deep network is a neural network with one or more hidden layers, and such machine learning model may be trained by, for example, adjusting weights of a neural network in accordance with a backpropagation learning algorithm or the like.

Once the editing assistant service determines that the machine learning model is trained and ready for use, the editing assistant service can provide the selected subset of content and writing style to the trained machine learning model as an input to the trained machine learning model. The editing assistant service can obtain, from the trained machine learning model, characteristics of sentence structure for the given subset of the content to be aligned with the specified writing style. For example, some characteristics of sentence structure can include specific words (e.g., a particular tense for verbs included in the subset of the text, a repeatedly used adjective in the specified writing style) or phrases, sentence length, a type of sentence (e.g., simple sentence, compound sentence, complex sentence), and a grammatical voice (i.e., active voice or passive voice). The editing assistant service can determine how much of sentence structure associated with the subset of the content matches the characteristics of the sentence structure using natural language processing. If the similarity satisfies a threshold condition (e.g., over 70%), the editing assistant service can determine that the subset of the content is consistent with the writing style. In such a case, the editing assistant service does not provide any suggestion for editing.

On the other hand, at block 140, responsive to determining that the subset of the content in the online document is not consistent with the writing style, the editing assistant service can predict one or more content portions (e.g., words or sentences) for editing. The editing assistant

service can obtain the words or sentences for editing suggestion as an output of the trained machine learning model. Such words or sentences output from the trained machine learning model would have the same content of the subset of the text but composed in accordance with the specified writing style.

Alternatively, the editing assistant service can apply the characteristics of sentence structure (obtained as output of the trained machine learning model) to words in the subset of the text to predict one or more words or sentences for editing. For example, the subset of the text can be narrative and the writing style designated can be third person past tense writing style. The editing assistant service can obtain, from the trained machine learning model, words for appropriate third person past tense verbs as the characteristics of sentence structure. Then, the editing assistant service can identify such words for editing suggestion. As another example, the subset of the text can be the description of an action scene and the writing style designated can be an action scene writing style and/or “R.A. Salvatore” writing style. The characteristics of sentence structure can be punching short sentences and reiteration of a point by a following sentence in a different way to highlight an event that happened in the action scene using a particular adjective. The editing assistant service can apply these characteristics of sentence structure to the subset of the text by rearranging words, generating short sentences based on words included in the subset of the text. Further, the editing assistant service can replace a word in the subset of the text with an impactful action word or the particular adjective signifying the “R. A. Salvatore” writing style. If the user changes the writing style to “J.R.R. Tolkien” writing style, the editing assistant service can predict words or sentences that conform to the characteristics of sentence structure found in writings of J.R.R. Tolkien based on the trained machine learning model. In addition to providing editing suggestions, the editing assistant

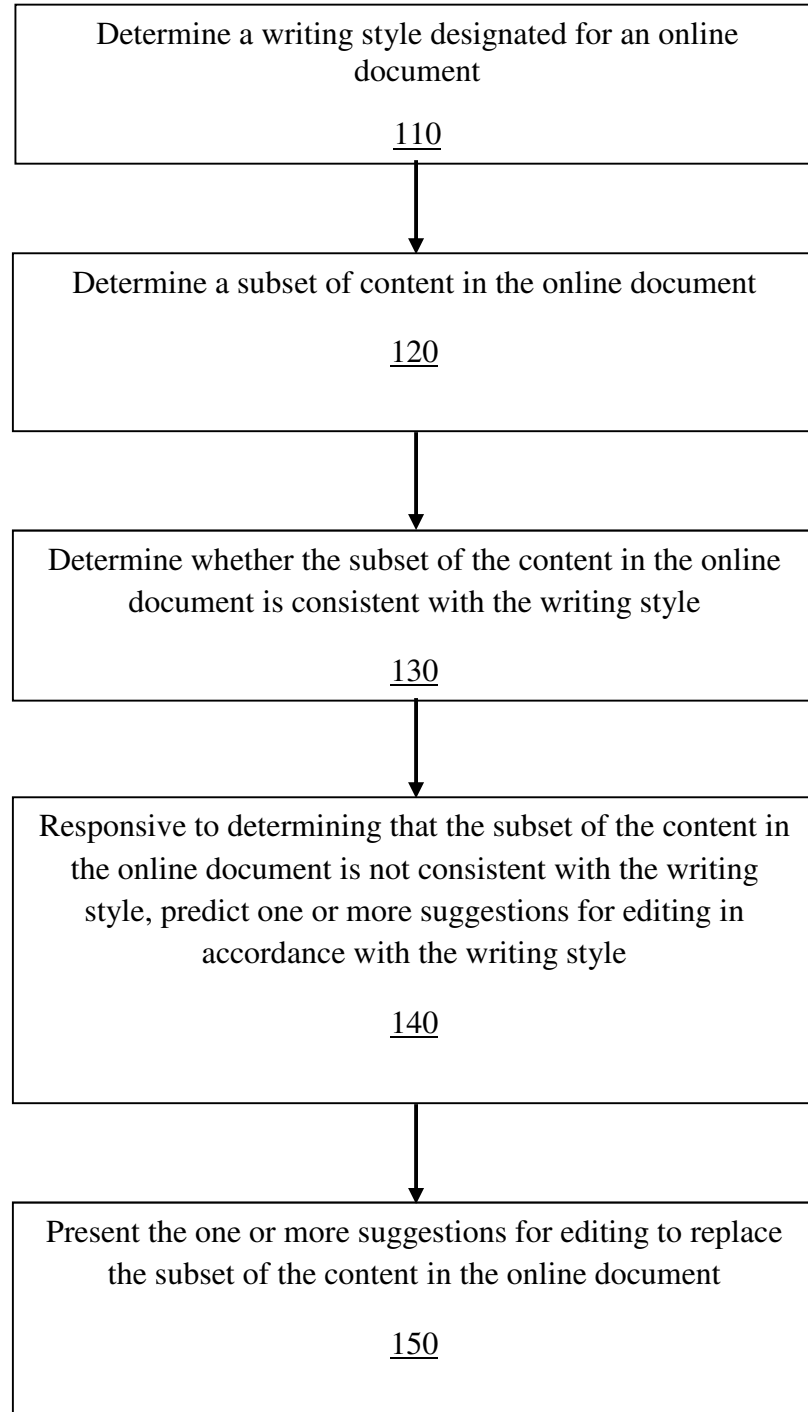
service can teach the user how to write in certain styles. Lastly, at block 150, the editing assistant service can present one or more suggestions (e.g., words or sentences) for editing to replace the subset of the content in the online document.



## **ABSTRACT**

A technique is proposed for assisting writing or editing an online document supported by a cloud-content based platform. An editing assistant service provided by the cloud-content based platform determines a writing style designated for the online document. The editing assistant service determines a subset of content in the online document. Then, the editing assistant service determines whether the subset of the content in the online document is consistent with the writing style. Responsive to determining that the subset of the content in the online document is not consistent with the writing style, the editing assistant service predicts one or more suggestions for editing in accordance with the writing style. Lastly, the editing assistant service presents one or more suggestions for editing to replace the subset of the content in the online document.

**Keywords:** editing assistant, writing assistant, writing style recommendation, tense correction, intelligent document editing, machine learning.



**FIG. 1**